

Radiation Stimulated Defect Formation and Mass Diffusion in Yttria-Stabilized Zirconia

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Solid solution $\text{ZrO}_2\text{-Y}_2\text{O}_3$ (YSZ) has been intensively investigated since it has many industrial applications in solid electrolytes for fuel cells, oxygen gas sensors and others. Key to these applications is high mobility of oxygen ions due to great concentration of oxygen vacancies. The present work is devoted to study the origin of radiation-induced defects and the effects of ionizing radiation on oxygen ion thermal diffusion in YSZ crystals. Due to the high light transparency of YSZ bulk crystals, indirect but simple and sensitive optical methods are acceptable to realize such investigations. Oxygen vacancies play a fundamental role as the precursor of electronic defects, which may be formed whenever electrons are mobilized in the crystal, as a result of exposure to ionizing radiation. One can observe a wealth of optical effects, in particular additional absorption and afterglow (AG), that is indicative of the presence of oxygen vacancies. The change of intensity of character AG peak at 280K related to oxygen vacancies is determined to be a criterion of the oxygen concentration changing. A kinetic property study revealed that the ionizing radiation influence during thermal annealing in an oxidizing ambient atmosphere incommensurably increases the oxygen diffusion rate on account of the lowering of the energy barrier height. Thermal treatment with no radiation influence shows that oxygen vacancy concentration decreases monotonically with annealing temperature increase while radiation influence is carried out the temperature dependence shows extreme character with minimum at 700K. Two concurrent processes seem to take place. Oxygen diffusion dominates in the lower temperature range, while radiation stimulated oxygen vacancy formation prevails at higher temperatures due to non-radiative relaxation of intrinsic electron excitations.